



PCT

**INFORMATION CONCERNING ELECTED
OFFICES NOTIFIED OF THEIR ELECTION**

(PCT Rule 61.3)

From the INTERNATIONAL BUREAU

To:

KOLSTER OY AB
Iso Roobertinkatu 23
P.O. Box 148
FIN-00121 Helsinki
FINLANDE

Date of mailing (day/month/year) 21 May 2001 (21.05.01)		IMPORTANT INFORMATION	
Applicant's or agent's file reference 2990692PC/nu			
International application No. PCT/FI00/00806	International filing date (day/month/year) 21 September 2000 (21.09.00)	Priority date (day/month/year) 22 September 1999 (22.09.99)	
Applicant ABB INDUSTRY OY et al			

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE
National : JP, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

None

3. The applicant is reminded that he must enter the "national phase" **before the expiration of 30 months from the priority date** before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into the European regional phase is postponed **until 31 months from the priority date** for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 740.14.35	Authorized officer: Charlotte ENGER Telephone No. (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

KOLSTER OY AB
Iso Roobertinkatu 23
P.O. Box 148
FIN-00121 Helsinki
FINLANDE

Date of mailing (day/month/year) 11 February 2002 (11.02.02)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 2990692PC/nu	
International application No. PCT/FI00/00806	International filing date (day/month/year) 21 September 2000 (21.09.00)

1. The following indications appeared on record concerning:									
<input checked="" type="checkbox"/> the applicant	<input type="checkbox"/> the inventor								
<input type="checkbox"/> the agent	<input type="checkbox"/> the common representative								
Name and Address ABB INDUSTRY OY Hiomotie 13 FIN-00380 Helsinki Finland	<table border="1"> <tr> <td>State of Nationality FI</td> <td>State of Residence FI</td> </tr> <tr> <td colspan="2">Telephone No.</td> </tr> <tr> <td colspan="2">Facsimile No.</td> </tr> <tr> <td colspan="2">Teleprinter No.</td> </tr> </table>	State of Nationality FI	State of Residence FI	Telephone No.		Facsimile No.		Teleprinter No.	
State of Nationality FI	State of Residence FI								
Telephone No.									
Facsimile No.									
Teleprinter No.									
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:									
<input type="checkbox"/> the person	<input checked="" type="checkbox"/> the name								
<input checked="" type="checkbox"/> the address	<input type="checkbox"/> the nationality								
<input type="checkbox"/> the residence									
Name and Address ABB OY Strömbergintie 1 FIN-00380 Helsinki Finland	<table border="1"> <tr> <td>State of Nationality FI</td> <td>State of Residence FI</td> </tr> <tr> <td colspan="2">Telephone No.</td> </tr> <tr> <td colspan="2">Facsimile No.</td> </tr> <tr> <td colspan="2">Teleprinter No.</td> </tr> </table>	State of Nationality FI	State of Residence FI	Telephone No.		Facsimile No.		Teleprinter No.	
State of Nationality FI	State of Residence FI								
Telephone No.									
Facsimile No.									
Teleprinter No.									
3. Further observations, if necessary:									
4. A copy of this notification has been sent to:									
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned								
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned								
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:								

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Silvie STENDER Telephone No.: (41-22) 338.83.38
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PCT COOPERATION TREATY

PCT

REC'D 11 JAN 2002

WIPO

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

3

Applicant's or agent's file reference 2990692PC/br	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FI00/00806	International filing date (day/month/year) 21.09.2000	Priority date (day/month/year) 22.09.1999
International Patent Classification (IPC) or national classification and IPC ₇ H 02 J 7/00, H 02 M 5/40		
Applicant ABB Industry OY et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 19.04.2001	Date of completion of this report 19.12.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Håkan Sandh/MN Telephone No. 08-782 25 00

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I. Basis of the report**1. With regard to the **elements** of the international application:***

- ☒ the international application as originally filed
- ☐ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:**

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

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V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims	<u>1</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report:

D1=EP 0911950

D2=WO 9716879

D3=DE19708842

Document D1 discloses a motor drive converter comprising a series connected DC capacitor bank having a resistor network serving as a balance network for the capacitor charging.

Document D2 discloses an arrangement for equalising the level of charge in battery cells connected in series. A balancing circuit comprises voltage converters connected on one side parallel with a battery cell and on the other side in parallel to provide a voltage source. The converters obtain energy from the battery cells and transfer the energy to a common path.

Document D3 discloses a balancing circuit for electric elements connected in series, i.e. batteries or capacitors. The balancing circuit comprises a resistor network.

The cited prior art discloses balancing circuits for capacitors or batteries connected in series. However, the claimed invention differs from the prior art in the use of freely oscillating inverters providing a voltage source. Such an arrangement is not considered to be obvious in view of the prior art.

Accordingly, the claimed invention is novel and considered to involve an inventive step. The invention is industrially applicable.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00806

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H02J 7/00, H02M 5/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H02M, H02J, H02H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0911950 A2 (GENERAL ELECTRIC COMPANY), 28 April 1999 (28.04.99), page 3, line 57 - page 4, line 4 --	1
Y	WO 9716879 A1 (XICON AB), 9 May 1997 (09.05.97), page 2, line 7 - line 13; page 3, line 1 - line 20 --	1
Y	DE 19708842 A1 (KAHLEN, HANS), 10 Sept 1998 (10.09.98), column 1, line 1 - line 41 -- -----	1

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

6 February 2001

Date of mailing of the international search report

09. 02. 2001

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

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Authorized officer

Håkan Sandh/MN

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INTERNATIONAL SEARCH REPORT

Information on patent family members

27/12/00

International application No.

PCT/FI 00/00806

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
EP	0911950	A2	28/04/99	BR	9804063 A	23/11/99
				CA	2249871 A	23/04/99
				US	5910892 A	08/06/99
WO	9716879	A1	09/05/97	AU	7511896 A	22/05/97
				CA	2235799 A	09/05/97
				CN	1201562 A	09/12/98
				EP	0858689 A	19/08/98
				JP	11514832 T	14/12/99
				PL	326385 A	14/09/98
				SE	507339 C	18/05/98
				SE	9503861 A	01/05/97
				US	6046573 A	04/04/00
DE	19708842	A1	10/09/98	NONE		

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
29 March 2001 (29.03.2001)

PCT

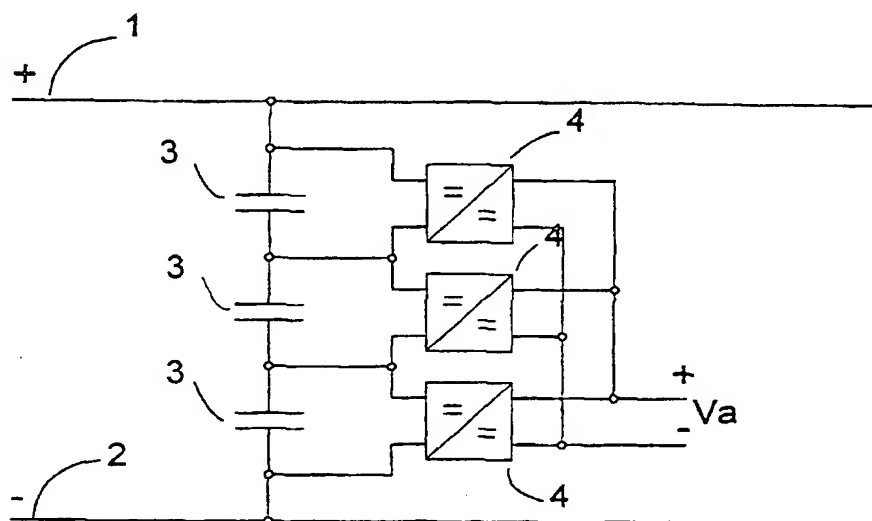
(10) International Publication Number
WO 01/22554 A1

- (51) International Patent Classification⁷: H02J 7/00, H02M 5/40 (74) Agent: KOLSTER OY AB; Iso Rooberinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).
- (21) International Application Number: PCT/FI00/00806 (81) Designated States (*national*): JP, US.
- (22) International Filing Date: 21 September 2000 (21.09.2000) (84) Designated States (*regional*): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 19992031 22 September 1999 (22.09.1999) FI
- (71) Applicant (*for all designated States except US*): ABB INDUSTRY OY [FI/FI]; Hiomotie 13, FIN-00380 Helsinki (FI).
- (72) Inventor; and
- (75) Inventor/Applicant (*for US only*): MIETTINEN, Erkki [FI/FI]; Kirkkokatu 1 b A 1, FIN-00170 Helsinki (FI).

Published:
— With international search report.
— Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: VOLTAGE BALANCING IN INTERMEDIATE CIRCUIT CAPACITORS



(57) Abstract: A balancing circuit for voltages of a series connection of capacitors, particularly for intermediate circuit capacitors (3) of an inverter, there being at least two intermediate circuit capacitors connected in series over intermediate circuit voltage. The balancing circuit comprises capacitor-specific freely oscillating inverters (4), the input poles of which are connected in parallel with the capacitor corresponding to the inverter and the output poles of which are connected in parallel to provide a voltage source (Va).

WO 01/22554 A1

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VOLTAGE BALANCING IN INTERMEDIATE CIRCUIT CAPACITORS

BACKGROUND OF THE INVENTION

The invention relates to a balancing circuit for voltages of a series connection of capacitors, particularly for intermediate circuit capacitors of a frequency converter, there being at least two intermediate circuit capacitors connected in series over intermediate circuit voltage.

Series-connected electrolyte capacitors are usually used as the energy reserve of the DC side in frequency converters. The number of capacitors to be connected in series depends on the supply voltage of the frequency converter, being usually one capacitor for 230 volts, two for 400 to 500 volts, three for 690 volts and four for 1000 volts. Series connections of capacitors can also be connected in parallel in an intermediate circuit. The number of parallel connections depends on the output current of the frequency converter.

The leakage currents of capacitors typically differ from one another, which means that the supply voltage of the static state acting over the series connection is not divided evenly between the capacitors. This may result in a situation where a single capacitor is subjected to a voltage which exceeds the allowed limit in the dynamic state due to the influence of current ripple and capacitance tolerances, for example. For this reason, 'balancing resistors' are usually connected in parallel with the capacitors, the current flowing through the resistors being much higher than the leakage current of the capacitors. In that case the voltage distribution in the static state is mainly determined by the resistance ratios of the resistors. It is also known in the art to use active components in addition to the resistors, e.g. emitter follower connections, which provide stricter restriction without an unreasonable increase in the power loss. However, the use of active components increases the component costs.

Typical balancing resistance for one capacitor in a frequency converter of 100 kVA is 22 kilo ohms, its power dissipation being 5.2 watts with 500 volts, for example. Since with this voltage there are two capacitors and resistors in series, the total power dissipation is 10.4 watts. With higher voltages the power dissipation is naturally even greater.

To operate the frequency converter needs a certain amount of auxiliary power for control circuits and gate drivers. This power is typically 10 to 20 watts in the case of a frequency converter of 100 kVA. It is easy to note that the amount of waste heat produced in the balancing resistors is nearly equal

to the amount of auxiliary power needed by the whole frequency converter. Thus it would be highly advantageous if the power dissipation required by balancing of capacitors could be utilized as the auxiliary power of the device.

BRIEF DESCRIPTION OF THE INVENTION

5 An object of the invention is to provide a circuit which allows to avoid the above-mentioned drawbacks and to balance voltages of a series connection of capacitors in a reliable manner so that an auxiliary voltage source is formed during voltage balancing. This object is achieved with a circuit according to the invention which is characterized in that the balancing circuit comprises capacitor-specific freely oscillating inverters, the input poles of which are connected in parallel with the capacitor corresponding to the inverter and the output poles of which are connected in parallel to provide a voltage source.

10 The circuit according to the invention is based on the idea that freely oscillating inverter circuits are used for balancing the voltages of series-connected capacitors, the inverter circuits converting voltage supply into voltage to be used in other circuits during voltage balancing. The circuit according to the invention provides the advantage that the power that would otherwise be lost can be utilized in low-power circuits, e.g. as auxiliary voltage in the control circuits and gate drivers of a frequency converter.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail by means of preferred embodiments with reference to the accompanying drawings, in which

25 Figure 1 illustrates a balancing circuit for voltages of a series connection of capacitors according to the invention; and

 Figures 2 and 3 illustrate inverters used for balancing voltages of capacitors according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

30 Figure 1 illustrates a balancing circuit for voltages of a series connection of capacitors according to the invention. The capacitors of Figure 1 are illustrated as capacitors of the intermediate circuit of a frequency converter but the circuit according to the invention can also be utilized in any other applications of the series connection of capacitors. The intermediate circuit of the frequency converter shown in the figure comprises a positive 1 and a negative 2

voltage busbar, between which there are three capacitors 3 connected in series. Figure 1 does not illustrate the actual inverter part of the frequency converter, i.e. power semiconductors and their control circuits because these components are irrelevant to the application and understanding of the invention.

According to the invention, a freely oscillating inverter 4 is connected to the poles of each series-connected capacitor. Examples of freely oscillating inverters are shown in Figures 2 and 3. According to Figure 1, the freely oscillating inverters are connected so that each series-connected capacitor comprises an inverter of its own. Thus the positive pole of each inverter is connected to the positive pole of the respective capacitor and the negative pole to the negative pole of the respective capacitor.

Using the circuit according to the invention the voltage of the electrolyte capacitors functioning as the power reserve of an intermediate circuit in a frequency converter can be balanced so that the auxiliary power needed by the frequency converter is generated at the same time. A freely oscillating inverter formed by two transistors 11, 12 and a converter 13 is connected in parallel with each capacitor, the centre 15 of the primary coil 14 of the converter being connected to the positive pole of the capacitor and the free ends of the same coil to the collectors of the transistors. This kind of embodiment of the invention is shown in Figure 2. Still referring to Figure 2, the emitters of the transistors 11, 12 are connected to the negative pole of the capacitor and the bases as well as a few passive components to the control coil of the converter according to the prior art to form a self-oscillating inverter. The self-oscillating inverter generally refers to the fact that no separate control circuits or timing circuits are used for controlling the semiconductor switches of inverter of this kind. Using passive components it is possible to provide an inverter in which there is no need for separate control power because the semiconductors conduct alternately thanks to oscillation.

In the self-oscillating inverter alternating voltage is induced in the secondary coil 16; 26 of the converter 13; 23, which is rectified with a rectifying bridge 17; 27 to provide a direct current that can be used as the auxiliary voltage. The full-wave rectified outputs of all inverters are connected together as shown in Figure 1 to provide an intermediate voltage V_a , e.g. $24\text{ V} \pm 30\%$, which is suitable for supply of auxiliary power. The number of turns of the secondary coil of the converters in the inverters is adjusted with respect to the

primary coil so that this voltage is achieved with a typical terminal voltage of the energy reserve capacitor. It is clear that large tolerances should be allowed for this intermediate auxiliary voltage because the range of variation of the primary voltage is also large.

5 Depending on the inverter solution used, the transistors of the inverter should withstand a voltage which is 1.2 or 2 times the capacitor voltage, which in the worst case, i.e. with a mains voltage of 500 volts and an overvoltage of 30%, is 878 volts. Thus it is possible to select transistors intended for a collector voltage of 1000 volts, in which case the inverter circuit is at its simplest (Figure 2), or transistors of 600 volts, in which case a few additional
10 components are needed for the circuit (Figure 3).

 The output and input voltages of the inverter circuit shown follow each other when multiplied by the transformation ratio of the converter, i.e. if the input voltage increases, rectified output voltage also increases accordingly.
15 The influence of any unideal properties of the inverter on this dependency is typically very small.

 Since the rectified outputs of the converters are connected together as shown above so that they retain their polarity, the auxiliary voltage power flows mainly through the converter with the higher secondary voltage. This
20 means that most of the auxiliary voltage power is taken from the energy reserve capacitor the terminal voltage of which tends to be the highest with respect to the other series-connected capacitors. Thus energy flows out of the capacitor, which means that the terminal voltage of the capacitor decreases until it reaches the second highest terminal voltage. However, this interaction
25 occurs simultaneously between all capacitors, and consequently the terminal voltages will be equal and the supply of auxiliary power is divided almost evenly between the inverters.

 This solution provides active balancing of energy reserve capacitors with virtually no loss of power, while the circuit can be used for supplying auxiliary voltage, e.g. in connection with a frequency converter.
30

 An additional advantage of the invention is that the components of the inverters are not dependent on the mains voltage. In all cases the number of series-connected inverters comprising the same components increases along with the input voltage, and thus expensive high-voltage switch components are not needed even with high supply voltages, which is the case in solutions based on separate auxiliary current sources driven directly by the in-
35

intermediate circuit voltage. If the supply voltage is around 1000 volts, standard switch components are not even available.

5 The output power of frequency converters tends to be higher when the supply voltage is high. In that case one needs more auxiliary power because the number of gate drivers is larger, but thanks to several series-connected intermediate circuit capacitors, a corresponding number of inverters the secondary circuits of which are connected in parallel are available for this purpose.

10 The inverter and its secondary rectifier used in the circuit according to the invention can be implemented easily using a piece of a circuit board, or as a unit cast in epoxy, which, being a low-loss unit, is easy to connect directly to the poles of a power capacitor. The price of such a volume component can be reduced considerably, and, if necessary, the converters can be provided with reinforced insulation, in which case the intermediate voltage of the auxil-
15 iary power can be rendered to the earth potential to enable parallel battery use when the intermediate circuit voltage has not been switched on or it is too low with respect to the normal operation. It is also easy to implement a blocking circuit for accidental start-up in the earth potential.

20 It is obvious to a person skilled in the art that the inventive concept can be implemented in various ways. The invention and its embodiments are thus not limited to the examples described above, but they may vary within the scope of the claims.

CLAIM

A balancing circuit for voltages of a series connection of capacitors, particularly for intermediate circuit capacitors (3) of an inverter, there being at least two intermediate circuit capacitors connected in series over intermediate circuit voltage, **characterized** in that the balancing circuit comprises capacitor-specific freely oscillating inverters (4), the input poles of which are connected in parallel with the capacitor corresponding to the inverter and the output poles of which are connected in parallel to provide a voltage source (Va).

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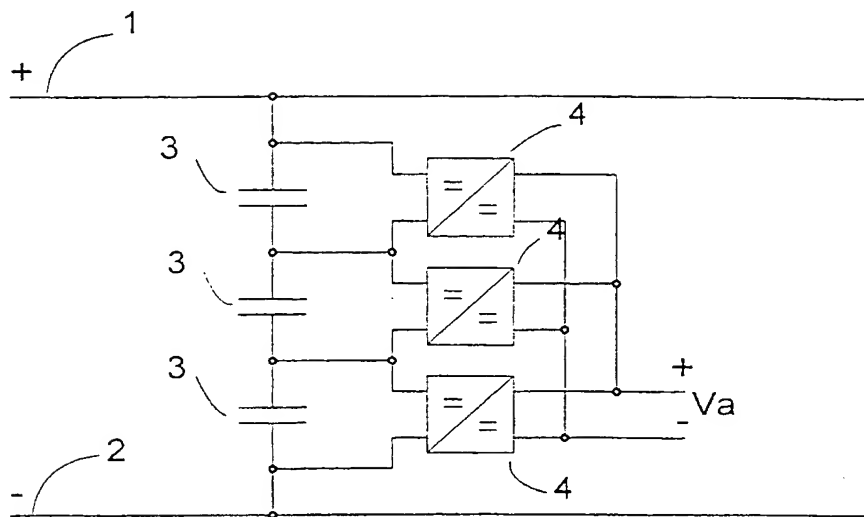


FIG. 1

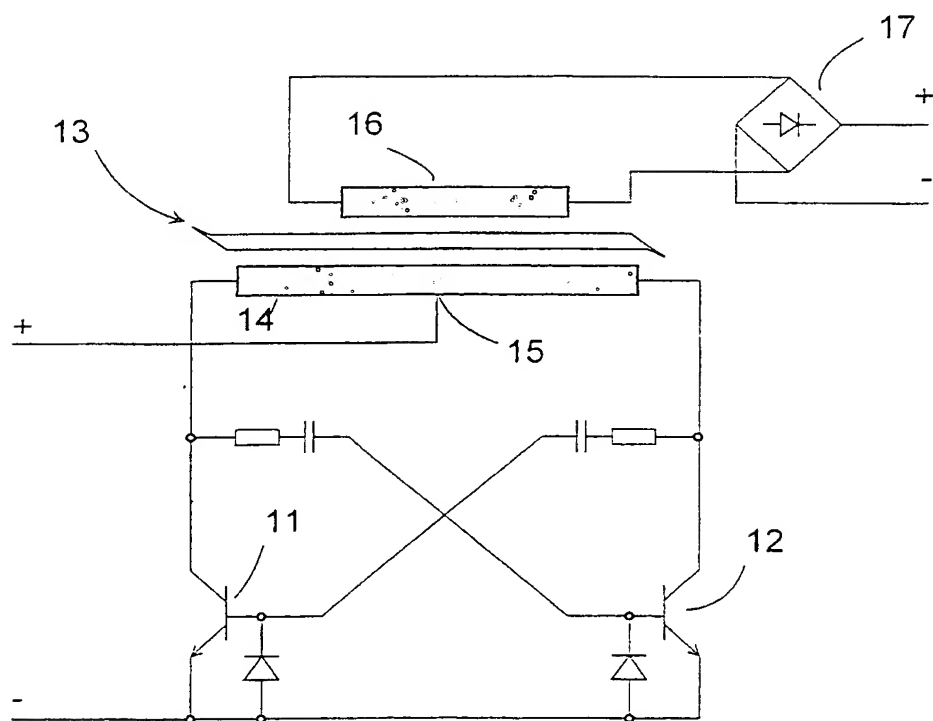


FIG. 2

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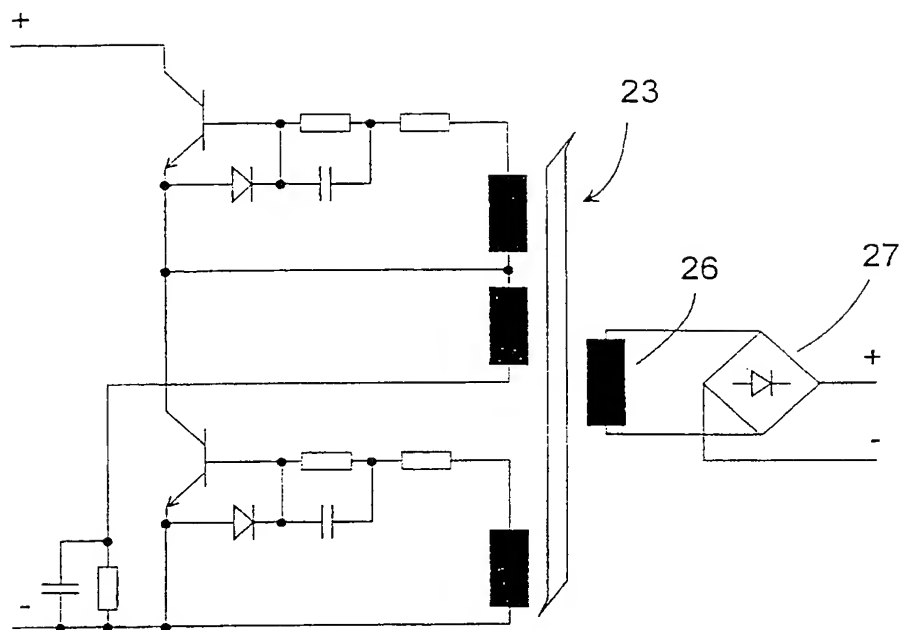


FIG. 3

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PCT REQUEST

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2990692PC/nu

Original (for SUBMISSION) - printed on 21.09.2000 12:49:10 PM

0 0-1	For receiving Office use only International Application No.	PCT/FI 0 0 / 0 0 8 0 6
0-2	International Filing Date	2 1 SEP 2000 (2 1 -09- 2000)
0-3	Name of receiving Office and "PCT International Application"	The Finnish Patent Office PCT International Application
0-4 0-4-1	Form - PCT/RO/101 PCT Request Prepared using	PCT-EASY Version 2.91 (updated 01.07.2000)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
0-7	Applicant's or agent's file reference	2990692PC/nu
I	Title of invention	VOLTAGE BALANCING IN INTERMEDIATE CIRCUIT CAPACITORS
II II-1 II-2 II-4 II-5	Applicant This person is: Applicant for Name Address:	applicant only all designated States except US ABB INDUSTRY OY Hiomotie 13 FIN-00380 Helsinki Finland
II-6 II-7	State of nationality State of residence	FI FI
III-1 III-1-1 III-1-2 III-1-4 III-1-5	Applicant and/or inventor This person is: Applicant for Name (LAST, First) Address:	applicant and inventor US only MIETTINEN, Erkki Kirkkokatu 1 b A 1 FIN-00170 Helsinki Finland
III-1-6 III-1-7	State of nationality State of residence	FI FI

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/ F 1 0 0 / 0 0 8 0 6

2/3

2990692PC/nu

PCT REQUEST

Original (for SUBMISSION) - printed on 21.09.2000 12:49:10 PM

IV-1	Agent or common representative; or address for correspondence The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	KOLSTER OY AB
IV-1-2	Address:	Iso Roobertinkatu 23 P.O. Box 148 FIN-00121 Helsinki Finland
IV-1-3	Telephone No.	358 9 618 821
IV-1-4	Facsimile No.	358 9 602 244
IV-1-5	e-mail	kolster@kolster.fi
V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	JP US
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	Exclusion(s) from precautionary designations	NONE
VI-1	Priority claim of earlier national application	
VI-1-1	Filing date	22 September 1999 (22.09.1999)
VI-1-2	Number	19992031
VI-1-3	Country	FI
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)

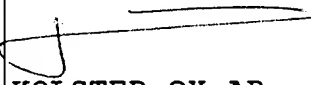
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PCT REQUEST

2990692PC/nu

Original (for SUBMISSION) - printed on 21.09.2000 12:49:10 PM

VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	3	-
VIII-2	Description	5	-
VIII-3	Claims	1	-
VIII-4	Abstract	1	2990692p.txt
VIII-5	Drawings	2	-
VIII-7	TOTAL	12	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-18	Figure of the drawings which should accompany the abstract	1	
VIII-19	Language of filing of the international application	English	
IX-1	Signature of applicant or agent	 Tapio Valkeiskangas	
IX-1-1	Name	KOLSTER OY AB	

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	21 SEP 2000 (21-09-2000)
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
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From the INTERNATIONAL BUREAU

PCT

**NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES**

(PCT Rule 47.1(c), first sentence)

To:

KOLSTER OY AB
Iso Roobertinkatu 23
P.O. Box 148
FIN-00121 Helsinki
FINLANDE

Date of mailing (day/month/year) 29 March 2001 (29.03.01)		
Applicant's or agent's file reference 2990692PC/nu		
IMPORTANT NOTICE		
International application No. PCT/FI00/00806	International filing date (day/month/year) 21 September 2000 (21.09.00)	Priority date (day/month/year) 22 September 1999 (22.09.99)
Applicant ABB INDUSTRY OY et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:

US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

EP,JP

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 29 March 2001 (29.03.01) under No. WO 01/22554

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a **demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

<p align="center">The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No. (41-22) 740.14.35</p>	<p align="center">Authorized officer J. Zahra</p> <p align="center">Telephone No. (41-22) 338.83.38</p>
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Continuation of Form PCT/IB/308



**NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF
THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES**

Date of mailing (day/month/year) 29 March 2001 (29.03.01)	IMPORTANT NOTICE
Applicant's or agent's file reference 2990692PC/nu	International application No. PCT/FI00/00806
<p>The applicant is hereby notified that, at the time of establishment of this Notice, the time limit under Rule 46.1 for making amendments under Article 19 has not yet expired and the International Bureau had received neither such amendments nor a declaration that the applicant does not wish to make amendments.</p>	

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